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Parapharyngodon anomalus sp. n. (Oxyurida, Pharyngodonidae) from the Australian Echidna *Tachyglossus aculeatus*, with Notes on the Thelandroinae

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ABSTRACT: A new species of the genus *Parapharyngodon, Parapharyngodon anomalus,* is described from the Australian echidna, *Tachyglossus aculeatus.* This nematode is morphologically similar to 2 previously described species which occur in Australian reptiles. This is the first report of a member of this genus occurring in a mammal. The significance of this finding is discussed.

KEY WORDS: *Parapharyngodon anomalus* sp. n., Oxyurida, Pharyngodonidae, *Tachyglossus aculeatus,* Tachyglossidae, Australia.

Twenty-two specimens of a pinworm belonging to the genus *Parapharyngodon* Chatterji, 1933 were recovered from the colon of a road-killed echidna *Tachyglossus aculeatus* (Shaw, 1792) (Monotremata: Tachyglossidae). Adamson and Nasher (1984a) considered members of this genus to be close to ancestral pharyngodonids, and the presence of a member of this genus in a primitive mammal may be of evolutionary significance. Although *Parapharyngodon* has not been reported from mammals previously, 2 species of the genus are known from Australian reptiles. The specimens from the echidna differ morphologically from these, and are considered to belong to a new species described herein as *Parapharyngodon anomalus* sp. n. after its unusual host affinities. The significance of this new species is discussed.

Materials and Methods

A single specimen of *Tachyglossus aculeatus* was found dead, apparently killed by a motor vehicle, in the Perth hills suburb of Lesmurdie, Western Australia. The gastrointestinal tract was sent to the author for parasitological examination. Two male and 20 female worms recovered from the colon were washed in tap water and fixed in hot glycerine alcohol.

Specimens were cleared in lactophenol. Drawings and measurements were made with the aid of a drawing tube. All measurements are given in μm unless otherwise indicated. Measurements given in the descriptions are of the male holotype and female allotype specimens. Specimens have been deposited in the Western Australian Museum, Perth.

The anterior extremity of one female worm was removed, dehydrated to absolute ethanol, critical-point dried via amyl acetate and carbon dioxide (Hayes, 1973), and sputter-coated with gold for visualization by a Philips scanning electron microscope (Model XL20).

I also examined *Parapharyngodon fitzroyi* Jones, 1992 paratypes WAM 15-91 (Western Australian Museum) ex *Tiliqua multifasciata*; *P. kartana* (Johnston and Mawson, 1941) Mawson, 1971 (syn. *Thelandros kartana* Johnston & Mawson 1941) SAM V1248, V1244 (South Australian Museum) ex *Hemiergis peronii*; *Thelandros trachysauri* Johnston and Mawson (1947) SAM V1242, V1243 ex *Trachydosaurus rugosus.*

Results

Parapharyngodon anomalus sp. n. (Table 1, Figs. 1–11)

DESCRIPTION: Oxyurida, Oxyuroidea, Pharyngodonidae, Thelandroinae. Robust worms with distinct transverse cuticular annulations. Mouth surrounded by 6 triangular lips. Cephalic extremity flattened, devoid of ornamentation, papillae, or external signs of amphids. Males with prominent lateral alae. Females without alae.

MALE (holotype WAM 5-95, paratype WAM 6-95): Figs. 1–3, Table 1. Length 5.28 mm, maximum width 490 at midbody. Lateral alae arise 1.1 mm from the anterior end and extend to about 100 μm from the posterior end. Excretory pore 1.83 mm from anterior end. Annulations at level of excretory pore 28 apart. Nerve ring 188 from anterior end. Buccal cavity 7 deep and 22 wide. Esophagus 880 long, including valved bulb; narrow part 58 wide, with short isthmus before bulb which is 145 long and 185 wide. Intestine greatly expanded immediately posterior to esophageal bulb. Posterior end with prominent postanal cone, gradually tapering to a bluntly rounded tip, bearing a pair of minute papillae. Dorsally directed caudal appendage 60 long, bearing a pair of sessile papillae at the proximal third, and ending in a sharp point. Two pairs of mammiform papillae, 1 adanal and

Table 1. Measurements of *Parapharyngodon anomalus* sp. n. All measurements are in μm unless otherwise indicated.

	Females		Males	
	Allotype	Paratypes*	Holotype	Paratype
Length (mm)	10.52	8.05–10.68 (9.98)	5.28	5.58
Maximum width	980	830–980 (895)	490	570
Esophagus length	1,550	1,325–1,575 (1,458)	880	910
Esophagus width	73	63–80 (72)	58	53
Esophageal bulb length	195	195–230 (213)	145	145
Esophageal bulb width	265	245–280 (263)	185	180
Nerve ring	205	195–240 (209)	188	—
Excretory pore	2,600	2,025–2,625 (2,425)	1,825	1,800
Tail spike	145	100–160 (137)	60	58
Vulva (mm from anterior)	5.05	3.68–5.05 (4.67)	—	—
Vulva (% of body length)	48	42.7–49.8 (46.8)	—	—
Anus–tail tip	465	400–500 (456)	—	—
Egg length	90	83–95 (89)	—	—
Egg width	45	43–50 (46)	—	—
Spicule	—	—	63	—

* $N = 15$; measurements given are ranges, with means in parentheses.

slightly anterior to anus, the other posterolateral to anus. Anterolateral margins of anus with several (8 or 9) fingerlike projections, some of which are branched, approximately 10 long. Spicule 63 long, weakly sclerotized. Spicule pouch opens immediately posterior to the anal opening.

FEMALE (allotype WAM 7-95, paratypes WAM 8-95): Figs 4–11, Table 1. Length 10.52 mm, maximum width 980 immediately anterior to vulva. Excretory pore 2.60 mm from anterior end. Annulations 56 apart at level of excretory pore. Nerve ring 205 from anterior end. Esophagus 1,550 long, including bulb, narrow part 73 wide with bulb 195 long and 265 wide. Intestine greatly expanded immediately posterior to esophageal bulb. Four loops of ovary coiled around esophagus immediately anterior to bulb. Vulva 5.05 mm from anterior end. Anus a horizontal slit in a slight depression, 465 from posterior extremity. Tail ends in a prominent stout spike approximately 145 long. Phasmids open laterally just anterior to the base of the tail spike. Eggs asymmetrical, measuring 90 × 45, flattened on one side, with subpolar operculum.

DIAGNOSIS: *Parapharyngodon anomalus* most closely resembles the other two Australian representatives of the genus, but is considerably larger (Table 2). Males possess a smaller spicule than those of *P. fitzroyi,* and a smaller tail appendage than both *P. fitzroyi* and *P. kartana.* Eggs of *P. kartana* are shorter than those of both *P. anomalus* and *P. fitzroyi.* Males of *P. anomalus* have a smoothly tapering genital cone, whereas those of *P. fitzroyi* have a small distal expansion on the genital cone.

Discussion

The genus *Parapharyngodon* has been twice relegated to synonymy with *Thelandros* (see Jones, 1992). In a major revision of *Thelandros,* Adamson (1981) reinstated the genus *Parapharyngodon* and considered these genera to be readily distinguishable by the presence of a prominent genital cone in males of *Thelandros,* and by differences in the eggs. *Thelandros* eggs have a terminal operculum, whereas the operculum of *Parapharyngodon* eggs is subterminal. Eggs of *Thelandros* are larvated in utero, while those of *Parapharyngodon* are deposited at an earlier stage of cleavage. In addition, Adamson (1981) noted that *Thelandros* spp. are parasites of omnivorous and herbivorous reptiles, whereas *Parapharyngodon* is found in insectivorous reptiles and amphibians. Adamson and Nasher (1984a, b) expanded these distinguishing criteria, in that males of *Thelandros* have pedunculate preanal and adanal papillae and a spicule pouch markedly posterior to the anus, whereas these papillae on males of *Parapharyngodon* are mammiform and the spicule pouch opens directly into the anus.

Two Australian species were considered in Adamson's (1981) revision. *Thelandros trachysauri* Johnston and Mawson (1947) was to remain in the genus *Thelandros* according to the text of Adamson's paper. However, it appeared

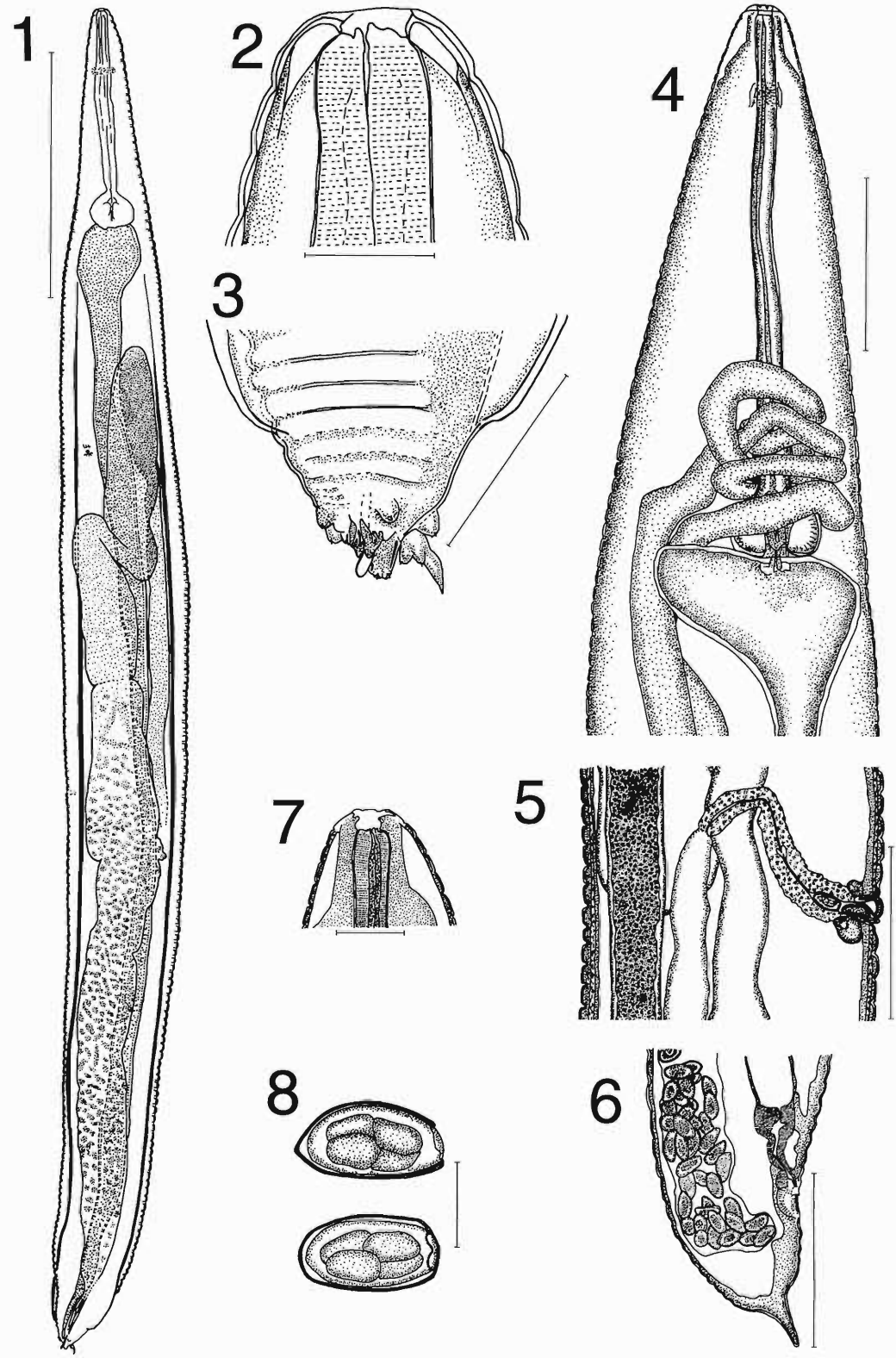

Table 2. Diagnostic comparison of the Australian species of the genus *Parapharyngodon*.

	P. anomalus sp. n.	*P. kartana*	*P. fitzroyi*
Body length (mm)			
Females	8.1–10.7	2.1–8.2	3.1–3.5
Males	5.3–5.6	1.6–4.2	2.0–2.4
Spicule length (μm)	63	55–65	80–92
Male tail appendage (μm)	58–60	50–90	60–80
Male genital cone	Smoothly tapering	—	Distal expansion
Egg length (μm)	83–95	75–90	88–96

in the abstract as being transferred to *Parapharyngodon,* and was not mentioned in a later compilation of *Thelandros* (Adamson and Nasher, 1984b). Type specimens viewed by the author, although not possessing pedunculate papillae, did display a prominent genital cone supported by a V-shaped sclerotized accessory piece, and eggs with terminal opercula, affirming their retention in *Thelandros.* Jones (1992) also considered this species to be a member of *Thelandros.*

Adamson (1981) placed the other Australian species, *T. kartana* Johnston and Mawson (1941) (=*T. khartana* of Adamson, 1981), in the genus *Parapharyngodon.* This species had already been transferred to *Parapharyngodon* by Mawson (1971), a fact that Adamson (1981) had overlooked. Although the male type specimen no longer has a posterior or anterior end, descriptions from the literature (Johnston and Mawson, 1941; Angel and Mawson, 1968; Mawson, 1971) indicate that the genital cone is not particularly prominent and is unlikely to be supported by a V-shaped sclerotized accessory piece. In the female type specimens, eggs have a subterminal operculum and the female has a rounded posterior with a stout spike tail. These characteristics all suggest *Parapharyngodon.* Note that material from *Hemiergis peronii,* listed as *Pharyngodon kartana* by Angel and Mawson (1968), is actually *Parapharyngodon kartana*; this error was transcribed in Adamson (1984).

In his description of *Parapharyngodon fitzroyi* from *Tiliqua multifasciata* in the northwest of Western Australia, Jones (1992) noted that this species could not be assigned easily to *Thelandros* or *Parapharyngodon.* It conformed to *Parapharyngodon* in egg structure, in the shape of the female tail, and in the mammiform rather than pedunculate papillae in the males. However, the prominent postanal cone and the separate opening of the spicule pouch posterior to the anus aligned it to *Thelandros.* Thus, Jones (1992) concluded that the definitions of these 2 genera have yet to be satisfactorily resolved. *Parapharyngodon anomalus* sp. n. clearly fits *Parapharyngodon* for egg shape and shape of the female tail and male papillae, but it also possesses a separate opening to the spicule pouch, and the postanal cone is quite prominent. Therefore, all 3 Australian species of *Parapharyngodon* appear to share some characters usually diagnostic for *Thelandros,* which may suggest they are close to the ancestor of both genera.

The genus *Parapharyngodon* is considered to be a relatively ancient member of the Pharyngodonidae (Adamson and Nasher, 1984a), so the finding herein of a species of *Parapharyngodon* in a primitive mammal might be taken as evidence that mammals were the original vertebrate hosts of this family. Since the other 2 families of extant Oxyuroidea, Heteroxynematidae and Oxyuridae, are primarily parasites of mammals (Adamson, 1989), a single origin of parasitism in mammals could be indicated for the Oxyuroidea. However, Adamson (1989) argued persuasively that reptiles are the ancestral hosts of Pharyngodonidae, and that *Parapharyngodon* may have its origins in ancient insectivorous lizards (Adamson and Nasher, 1984a). The new *Parapharyngodon* is morphologically very sim-

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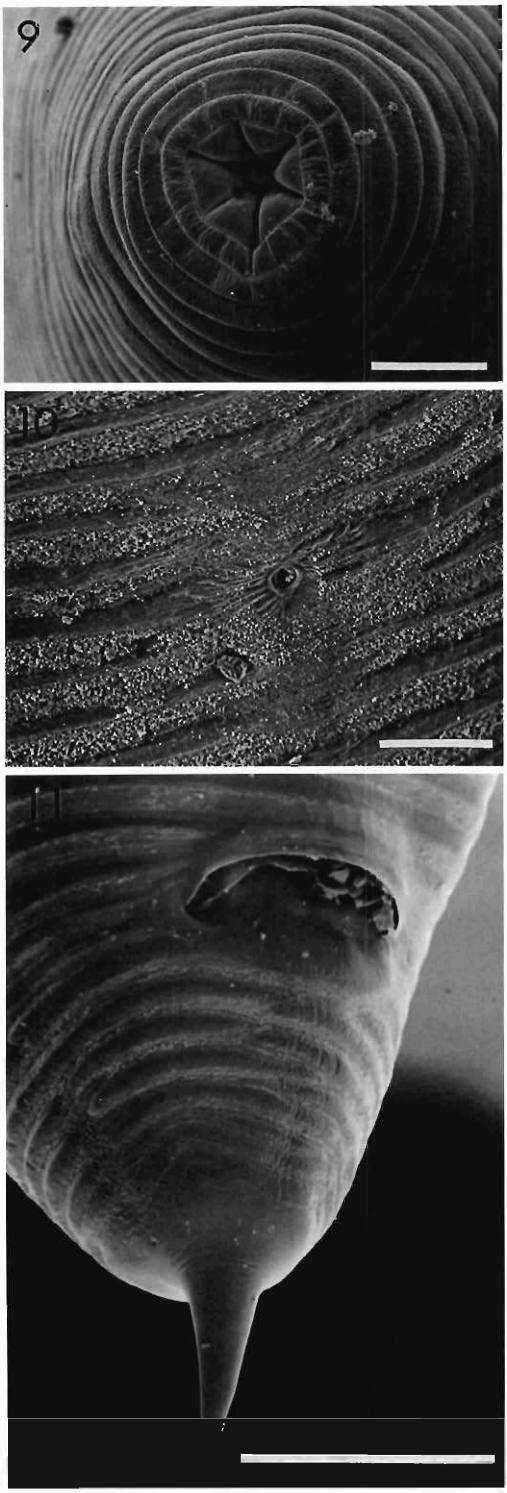
Figures 1–3. *Parapharyngodon anomalus* sp. n. male holotype. 1. Entire specimen anterolateral view. 2. Anterior end. 3. Posterior end. Scale lines: 1. 1 mm. 2. 50 μm. 3. 100 μm.

Figures 4–8. *Parapharyngodon anomalus* sp. n. female allotype. 4. Esophageal region. 5. Vulva. 6. Anus and tail tip. 7. Anterior end. 8. Eggs. Scale lines: 4. 500 μm, 5. 500 μm. 6. 500 μm. 7. 100 μm. 8. 50 μm.



Figures 9–11. Scanning electron micrographs of *Parapharyngodon anomalus* sp. n. female. 9. En face. 10. Excretory pore. 11. Tail tip. Scale bars: 9. 50 μm. 10. 50 μm. 11. 200 μm.

ilar to other species of the genus found in modern Australian reptiles and it is likely that the line in reptiles would have diverged further than this had it originated in primitive mammals. Thus, *Parapharyngodon anomalus* sp. n., unlike other known parasites of echidnas (Inglis, 1968; Beveridge, 1980; Durette-Desset and Chabaud, 1981; McOrist and Smales, 1986), is most likely a relatively recent acquisition to the echidna parasite fauna, probably derived from host-switching with a recent reptilian species. This interpretation therefore does not refute the hypothesis of a reptilian ancestral host for the Pharyngodonidae.

A number of studies have reported helminths from echidnas, and the fauna is quite rich, with 2 endemic species of cestode, and 10 endemic trichostrongyloid nematodes (Spratt et al., 1990). However, these parasites appear to be relatively uncommon, and McOrist and Smales (1986) reported prevalences of only 12% both for the cestode *Linstowia echidnae* and for trichostrongyloid nematodes in a sample of 73 echidnas from Victoria in SE Australia. This combination of rich helminth fauna and low prevalence in echidnas, and the fact that Western Australia has been poorly sampled, supports the premise that this finding represents a new species and not just an incidental infection. The absence of this worm in the extensive survey of McOrist and Smales (1968) suggests that *P. anomalus* sp. n. may be restricted to Western Australia.

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